Abstract

The capacity spectrum method is a very popular tool in the performance based earthquake resistant design of structures. Though it involves non-linear static analysis, it can be used to predict the dynamic behaviour of the building under earthquake load. Since the analysis is only static and not dynamic, it is very well suited for the design offices and low end computer terminals as opposed to dynamic analysis which is very resource consuming.

There are several methods/variations of methods, to perform the non-linear static analysis, popularly known as pushover analysis and convert it to capacity spectrum. *Displacement based pushover analysis, force based pushover analysis, modal pushover analysis, energy based pushover analysis etc.* are some of the variations of pushover analysis. There are a few attempts to consider the change in mode shape but all the methods are silent about the change in frequency due to formation of hinges in the structure. The available codes for building design such as ATC-40 provide some guidelines for getting the capacity spectrum but are not yet developed for proper ductility consideration while converting the pushover curve to capacity spectrum.

The present study tries to address the above issues while proposing a new energy based approach to draw capacity spectrum.

The *chapter 1* introduces the concept of pushover analysis and capacity spectrum concepts. Different approaches to get these curves, their theoretical background, variations and limitations are discussed as a quick review.

Chapter 2 is about the review of literature present on these topics. It is found that most of the studies have been carried out in the past on the framed buildings regarding the pushover analysis. In the last few years attempts are also made to consider the effect of torsion.

Summarising the various contributions till now, it may be concluded that even in the earlier multimode pushover analysis the effect of different modes on the only static force distribution was considered. Further

the spectral acceleration is obtained as a ratio of base shear and α times the weight of the building, where α is the modal mass coefficient. Only the first mode frequency could be utilized to convert the maximum displacement at the top to the spectral acceleration and the corresponding maximum potential energy (P.E.) could be used for equivalence of MDOF and SDOF. Therefore in *chapter 3* which follows, the above limitation is removed as explained below.

In *chapter 3*, the new methodology based on energy equivalence consideration is proposed step by step. For the given multistorey building, a displacement profile is applied to the building which is proportional to the effective mode shape. The effective mode shape can be the first mode shape or a combination of first few mode shapes. In the present study, two cases are considered. In the first case, the effective mode shape is considered to be the first mode shape itself whereas in the second case the effective mode shape is considered to be a linear combination of first three modes weighted by corresponding participation factors. After this, a nonlinear static analysis is performed on the structure considering the above displacement profile. Due to the above provided displacement profile, there will be yielding in the structure at a few locations. The yielded structure is again analysed for eigenvalues and mode shapes and the first three mode shapes are extracted along with their participation factors. Again the deflected structure is subjected to the deflection proportional to the effective mode shape and the analysis is continued until the collapse. The chapter also describes the details of the model used for simulation. Two kinds of simulation are performed on the model. One is considering only single mode of vibration whereas the other is considering the multiple modes (3 in this case) of vibration of the structure.

Chapter 4 discusses the results of the simulations performed on the model. Single mode and multimode cases are treated and discussed separately.

The proposed method is in its nascent stage and hence a lot of modification and validation work is needed to consider the method acceptable. The *chapter 5* concludes the overall outcome of the present study and provides scope for the further study.